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MAMMAL DISTRIBUTION IN THE ALAMOGORDO REGION, NEW MEXICO

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THE Alamogordo region of New Mexico is of great interest biogeographically because of the great diversity of environmental conditions to be found within a small territory. Within a distance of less than twenty miles may be found all the belts of life from desert plain to spruce and fir forest. Furthermore, on the desert plain are to be found extensive areas of white gypsum sands and of black lava rocks, each with associated peculiar forms of animal life.

The University of Michigan-Walker-Harris Expedition of 1927 worked in the Alamogordo region from June 28–August 5. The party consisted of G. W. Bradt, Robert Bradley, S. C. Whitlock, and the author. The time spent in the field was too short to determine in detail the distribution of all the mammals over such a varied area. Furthermore the field work was all done at one season and in one year, so that no information is at hand concerning seasonal or annual variations in distribution or abundance. However, by the use of an automobile and with a fairly large party we were able to work intensively the more common habitats, especially near the city of Alamogordo. Three trips were made to the White

Sands, but only one night could be spent on the Malpais lava-beds. The whole region will well repay more intensive study. For identification of the plants collected, I am indebted to Mrs. Lois Ehlers. The names for species not collected have been taken from Bailey (1913).

Physiography

The city of Alamogordo lies at the eastern margin of a nearly level desert plain, which is bounded on the east by the Sacramento Mountains and on the west by the San Andreas Mountains. This desert plain, the Tularosa Desert, covers an extensive area in southern New Mexico, being over thirty miles wide at Alamogordo.

Near Alamogordo the middle of the Tularoso desert has an elevation of about 4000 feet, and the plain slopes gently upward toward the mountains on each side. The mountains rise abruptly at the margins. There are no streams on the plain, but arroyos, which are dry most of the year, lead out from the mountain canyons, and in places other washes occur. After heavy rains temporary lakes may be formed at various places on the plain. Except near the mountain tops all the waters and soils are heavily charged with alkaline salts.

About twelve miles west of Alamogordo, near the middle of the desert plain, lie the White Sands. These cover an area of about 270 square miles (Meinzer and Hare, 1915, p. 45). Although composed of nearly 95 per cent. pure gypsum (Coville and MacDougal, 1903, pp. 9–10) the soil particles are nevertheless shaped by the wind into dunes and dune complexes, similar to those formed by ordinary sand. As one might expect from their composition the White Sands are dazzling white in color, faintly tinged with buff.

Just north of the area of white gypsum sand lies an area of approximately 100 square miles covered with quartz sand, mixed in part with gypsum sand. This area also is shaped by the winds into dunes (Meinzer and Hare, 1915, p. 46). We made no study of this area. Its fauna is probably not very different from that of the sandy mesquite areas which were

studied near Alamogordo, but its mammal population should be determined with certainty.

The area of quartz sand extends north to within a few miles of the Malpais, which is a bed of black lava covering an area of about 120 square miles (Meinzer and Hare, 1915, p. 34).

All these physiographic features occur in the same desert plain, and at almost the same altitude. The areas of mesquite near Alamogordo studied by us lie at an elevation of 4200–4250 feet; triplex was studied at 4100 feet; the White Sands are at about the same elevation; and the lava at Malpais Spring is at about 4175 feet (Meinzer and Hare, 1915, pl. 2).

On the eastern side of the Tularosa Desert the Sacramento Mountains rise steeply to an altitude of about 9000 feet. Deep canyons cut into these mountains, and the western slopes are in general quite steep. The summit of the range forms a ridge, more or less cut by erosion, but there are no outstanding peaks.

Climate

A considerable difference in climate prevails in the various parts of the Alamogordo region, correlated with the variations in altitude and in slope exposure. On the desert the summers are long and hot and the winters moderate, with, however, occasional periods of temperatures below zero. At the summit of the Sacramento Mountains the summers are fairly cool and the winters moderately severe.

Meteorological summaries are given in Table I, which is based on data supplied by the United States Weather Bureau. The *mean maximum* and *mean minimum* given for each month are the averages respectively of the daily maxima and minima. The *mean* is midway between the mean maximum and the mean minimum.

At Cloudcroft (altitude 8650 feet), near the summit of the mountains, the annual mean temperature is 44.0° F., while at Alamogordo (elevation 4250 feet), at the edge of the desert plain, the annual mean is 60.9°. In the summer months the difference in temperature between the mountain top and the

TABLE 1. METEOROLOGICAL DATA

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mountain summit													
Cloudcroft													
Temperature °F.													
Mean	29.6	31.1	36.4	41.5	49.6	57.4	59.2	58.1	53.8	45.8	36.9	28.7	44.0
Mean maximum	39.8	41.0	46.6	52.7	62.1	70.2	70.9	68.5	64.8	57.0	47.5	38.5	55.0
Mean minimum	19.9	21.2	26.1	30.8	37.4	44.4	47.5	47.5	42.7	34.9	26.3	19.1	33.1
Maximum	64	63	70	70	85	85	85	85	85	80	65	58	85
Minimum	−10	−4	−2	8	17	27	36	34	26	12	−5	−7	−10
Precipitation inches	1.71	1.66	1.39	1.03	0.56	1.79	3.91	4.28	2.93	1.41	1.32	1.41	23.39
Pinyon-cedar belt													
Mountain Park													
Precipitation inches	1.38	0.99	1.38	1.17	0.50	1.78	3.60	3.48	2.48	1.88	0.88	1.28	20.80
Desert Plain													
Alamogordo													
Temperature °F.													
Mean	43.3	46.3	53.1	59.8	68.4	78.0	79.8	78.0	72.1	60.8	50.3	41.4	60.9
Mean maximum	57.4	60.5	68.3	76.4	85.9	94.8	95.2	92.8	86.7	75.9	65.1	55.2	76.2
Mean minimum	29.3	32.2	37.8	43.2	51.0	60.9	64.3	63.2	57.5	45.6	35.5	28.5	45.8
Maximum	86	90	99	104	105	109	109	108	100	98	84	75	109
Minimum	−8	4	10	25	30	41	49	48	38	23	8	0	−8
Precipitation inches	0.58	0.60	0.59	0.57	0.33	0.82	1.72	2.21	1.40	0.96	0.71	0.69	11.18

desert is about 20°; in the winter the difference is considerably less.

The average length of the frostless season on the desert at Alamogordo is 208 days; in the pinyon-cedar belt at Mountain Park it is 169 days; and near the summit of the mountains at Cloudcroft it is 140 days. The length of the period between the last known killing frost in spring and the earliest killing frost in autumn is 155 days at Alamogordo, 136 days at Mountain Park, and 100 days at Cloudcroft. It is interesting to note such a long frost-free period on the summit of the mountain range.

The total yearly precipitation on the desert is insufficient to balance evaporation, and no water is available to drain away in rivers, although a small amount may be drained from the basin underground. Consequently, in the lower part of the desert plain the soluble salts accumulate in the soil to such an extent that many non-tolerant plants are excluded. On the other hand, the mountain summits receive a larger amount of moisture and the alkaline salts are washed down to lower elevations.

The intermediate levels on the mountain slopes receive not a great deal less precipitation than the summits. At Mountain Park in the pinyon-cedar belt the average annual precipitation is 20.8 inches, compared to 23.39 inches at Cloudcroft on the summit. But the evaporation must be much greater on these exposed western slopes, and heavy forests are not able to grow.

The heaviest precipitation of the year comes in late summer, beginning usually in July. At this season the rains mostly accompany thunderstorms. In winter the precipitation falls mostly in general storms. May has the least precipitation of all the months, and in June the desert lies baked and desiccated.

In the Sacramento Mountains a large part of the precipitation falls as snow; the average annual snowfall at Cloudcroft is 75.9 inches. On the desert, however, there is very little snow in winter; the average annual snowfall at Alamogordo is

but 7.1 inches. At Mountain Park, in the pinyon-cedar belt, the average snowfall, 34.5 inches, is intermediate between these extremes.

Faunal and Ecological Divisions of the Alamogordo Region

As a tentative organization the major ecological communities of the region may be grouped as follows:

Desert

- Desert Plain
  - Mesquite community
  - Creosote bush community
  - Atriplex community
  - Alkali meadow community
  - Alkali marsh and pool community
  - Aerial community
- White Sands
  - Sumac-yucca community
  - Grama grass-joint fir community
- Malpais
  - Malpais lava community
- Desert mountain slope
  - Sotol-octotillo community
  - Rocky arroyo community

Pinyon-cedar woodland

- Pinyon-cedar community
- Oak-poplar community
- Aerial community

Montane forest

- Oak chaparral community
- Yellow pine community
- Douglas fir community
- Spruce-fir community

In this paper every habitat has been described which appeared to the author to constitute a distinct mammalian

environment and which was at the same time large enough possibly to serve as the range of even the smaller species of mammals. The data secured on the habitat preferences and limitations of the mammals are insufficient to establish conclusively the mammalian communities, and the mammalian faunas of several habitats here recognized as distinct may prove to be nearly or exactly similar.

In distinguishing between habitats much dependence has been placed upon plants and soil conditions. It is assumed that where the plants themselves do not produce a principal part of the animal environment they will often indicate those soil and climatic factors which do determine the limits of range or abundance for mammalian species.

Desert

The desert at Alamogordo consists of two primary subdivisions, the desert plain and the lower slopes of the mountains. On the desert plain the gypsum of the White Sands and the black lava of the Malpais each dominate extensive areas.

The following mammals taken by us are characteristic of the desert:

Antrozous pallidus pallidus. Pallid bat.
Citellus spilosoma arens. Sand squirrel.
Cynomys ludovicianus arizonensis. Prairie-dog.
Thomomys lachuguilla. Lechuguilla pocket-gopher.
Perognathus flavus flavus. Baird pocket-mouse.
Perognathus gypsi. White Sands pocket-mouse.
Perognathus penicillatus eremicus. Desert pocket-mouse.
Perognathus intermedius intermedius. Rock pocket-mouse.
Perognathus intermedius ater. Malpais pocket-mouse.
Dipodomys merriami merriami. Merriam kangaroo-rat.
Dipodomys ordii ordii. Ord kangaroo-rat.
Onychomys leucogaster ruidosae. Ruidosa grasshopper-mouse.
Onychomys torridus torridus. Coues grasshopper-mouse.
Reithrodontomys megalotis megalotis. Desert harvest-mouse.
Peromyscus eremicus eremicus. Cactus mouse.
Peromyscus maniculatus blandus. Chihuahua deer-mouse.
Sigmodon minimus minimus. Desert cotton-rat.
Neotoma micropus canescens. Hoary woodrat.

Neotoma albigula albigula. White-throated woodrat.
Neotoma albigula melas. Malpais woodrat.
Lepus californicus texianus. Texas jack-rabbit.
Sylvilagus audubonii minor. Desert cottontail.

Of the above listed forms the jack-rabbit and the cottontail range above the desert into the pinyon-cedar woodland, and it is likely that a few of the other forms listed will also be found in higher life belts when their ranges are better known. The list would be considerably extended if the characteristic desert carnivores and ungulates and other forms not taken by us were added.

The large number of characteristic desert species and subspecies indicates a long period of existence of desert conditions over geologic time in this part of North America.

DESERT PLAIN COMMUNITIES

Mesquite community:

1907. *Mesquite association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.

Lynx sp. Wild cat, reported.
Citellus grammurus grammurus. Rock squirrel, 2.
Citellus spilosoma arens. Sand squirrel, 2.
Cynomys ludovicianus arizonensis. Prairie-dog, few.
Thomomys lachuguilla. Lechuguilla pocket-gopher, 1.
Perognathus flavus flavus. Baird pocket-mouse, 1.
Perognathus eremicus eremicus. Desert pocket-mouse, 26.
Dipodomys ordii ordii. Ord kangaroo-rat, 11.
Dipodomys merriami merriami. Merriam kangaroo-rat, 27.
Onychomys leucogaster ruidosae. Ruidosa grasshopper-mouse, 1.
Onychomys torridus torridus. Coues grasshopper-mouse, 6.
Reithrodontomys megalotis megalotis. Desert harvest-mouse, 30.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 111.
Sigmodon minimus minimus. Desert cotton-rat, 1.
Neotoma micropus canescens. Hoary wood-rat, 5.
Lepus californicus texianus. Texas jack-rabbit, numerous.
Sylvilagus audubonii minor. Desert cottontail, few.

The mesquite (*Prosopis glandulosa*) dominates extensive areas on the desert plain near Alamogordo. This shrub grows usually in rather widely spaced clumps, and reaches

a height of 3 to 10 feet. In the more sandy areas the soil tends to heap up about the bases of the clumps, which thus become raised above the general ground level, sometimes to a height of nearly two feet. Several species of atriplex (*Atriplex canescens, A. greggii?*) are numerous in this habitat, and a mustard (*Lepidium*) is common in the sandy portions. Stems of dried grasses indicate that earlier in the season there must be a fair growth of grass. A few crucifixion thorn (*Koeberlinia spinosa*) occur. However, the vegetation covers the ground only thinly, and there are many bare spots.

The most common mammals are the Chihuahua deer-mouse, harvest-mouse, two species of kangaroo-rat, desert pocket-mouse, jack-rabbit, and cottontail. Of lesser abundance are the hoary woodrat, two species of grasshopper-mice, the prairie-dog, and several other forms of small mammals. Many of these mammals at the time of our visit were feeding extensively on the mesquite beans.

Creosote bush community:

1907. *Creosote bush association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.

Canis mearnsi. Mearns coyote, signs.
Dipodomys merriami merriami. Merriam kangaroo-rat, 9.
Onychomys torridus torridus. Coues grasshopper-mouse, 2.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 10.
Lepus californicus texianus. Texas jack-rabbit, few.
Sylvilagus audubonii minor. Desert cottontail, few.

On the gravelly and gently sloping apron bordering the base of the Sacramento Mountains the dominant plant is the creosote bush (*Covillea glutinosa*), which grows in an open stand to a height of 4 to 6 feet. Rarely a mesquite or a small yucca may be found. A small mustard was numerous in early July. Crossing the habitat are numerous small natural channels, which evidently are filled with water during heavy rains. A few arroyos also cross this habitat, leading out from the mountain canyons. As these arroyos contain some plants and mammals not characteristic of the creosote bush community they are here considered to form a distinct ecological habitat.

Atriplex community:

1907. *Atriplex association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.

Citellus spilosoma arens. Sand squirrel, 1.
Dipodomys merriami merriami. Merriam kangaroo-rat, 5.
Dipodomys ordii ordii. Ord kangaroo-rat, 4.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 1.
Lepus californicus texianus. Texas jack-rabbit, few.
Sylvilagus audubonii minor. Desert cottontail, signs.

The atriplex community was studied about 9 miles west of Alamogordo, where it covers a strip several miles wide, extending from the mesquite community to the White Sands. *Atriplex canescens* occurs commonly as a low shrub, and the bunch-grass *Sporobolus* is also common (Coville and MacDougal, 1903, p. 5), both being very desiccated in early summer. A few crucifixion thorn are present and some Opuntias, but a considerable proportion of the ground is bare of vegetation.

Besides the species of small mammals listed from this community the presence of woodrats is indicated by heaps of trash about the bases of some of the shrubs, but as no specimens were taken the species is uncertain.

Alkali meadow community:

Reithrodontomys megalotis megalotis. Desert harvest-mouse, 4.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 2.
Sigmodon minimus minimus. Desert cotton-rat, 1.
Lepus californicus texianus. Texas jack-rabbit, common.
Sylvilagus audubonii minor. Desert cottontail, signs.

An alkali meadow covers the bottom of a rather wide wash about 6 miles southwest of Alamogordo. The soil is fine and somewhat moist, but is incrusted with whitish salts. In a small field in this wash fenced against cattle is a fairly thick stand of tall grasses, some herbs, and a few scattered low shrubs. The glasswort (*Allenrolfea occidentalis*) is said by Coville and MacDougal (1903, p. 5), to occur in this type of habitat.

Trapping for one night secured the harvest-mouse, deer-mouse, and cotton-rat; signs of the cottontail were seen; and a few jack-rabbits were noted. Doubtless other species of mammals would be found on more extensive study.

Alkali marsh and pool community:

The outflow from Malpais Spring produces a marsh covering many acres. The water is heavily impregnated with salts, but nevertheless there is a thick growth of sedges and cattails. No signs of small mammals could be found in this marsh and a small number of traps which were set remained undisturbed. In the pool formed by the spring and in the small outflow stream a small fish (*Cyprinodon*) was common, and a number of snails were found.

Aerial community (desert):

Pipistrellus hesperus hesperus. Canyon bat, numerous.
Antrozous pallidus pallidus. Pallid bat, 1.

The only bats seen on the desert were noted at Malpais Spring. Probably the numerous crevices in the lava nearby furnish roosting places, which must elsewhere on the desert plain be rare.

WHITE SANDS COMMUNITIES

Sumac-yucca community:

1907. *Sumac-Yucca association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.

Canis mearnsi. Mearns coyote, tracks.
Perognathus gypsi. White Sands pocket-mouse, 5.
Dipodomys merriami merriami. Merriam kangaroo-rat, 3.
Dipodomys ordii ordii. Ord kangaroo-rat, 4.
Onychomys leucogaster ruidosae. Ruidosa grasshopper-mouse, 1.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 8.
Lepus californicus texianus. Texas jack-rabbit, few.
Antilocapra americana subsp. Pronghorned antelope, reported.

As previously stated the White Sands dominate an area on the desert plain estimated to cover 270 square miles. A large

part of this area is covered by more or less active dunes of nearly pure gypsum. On these dunes is a very characteristic but sparse vegetation characterized by the three-leaf sumac (*Sumac trilobata*). "Other characteristic woody plants of the dunes are *Atriplex canescens,* two species of *Chrysothamnus,* and *Yucca radiosa*" (Coville and MacDougal, 1903, p. 6). This habitat was very briefly examined and it needs further study.

The most noteworthy mammal of these dunes is the White Sands pocket-mouse, a tiny nearly white pocket-mouse, whose existence was not previously suspected. Some woodrat houses were seen, but no animals were secured for identification.

Grama grass-joint fir community:

Between the active dunes of the White Sands are found depressions having sometimes about the same level as the general desert plain. These bottoms have a fairly dense vegetation "characterized especially by the presence of a grama grass (*Bouteloua*) forming almost a turf, and by frequent clumps of Ephedra" (Coville and MacDougal, 1903, p. 6–7). We made no particular study of this habitat and have no record of mammals.

MALPAIS COMMUNITIES

Malpais lava community:

Perognathus intermedius ater. Malpais pocket-mouse, 4.
Peromyscus eremicus eremicus. Cactus mouse, 2.
Neotoma albigula melas. Malpais woodrat, 1.
Sylvilagus audubonii minor. Desert cottontail, few.

Where studied at Malpais Spring, 15 miles west of Three Rivers, the edge of the lava flow is sharply marked; the lava rises 10 to 20 feet above the level of the surrounding plain. Near this place, which is at the southern extremity of the Malpais, the lava is several miles in width. The blackish lava rock is somewhat broken into jagged masses, with many cracks and small caves. In the crevices of the rocks a small amount of soil has collected and there is a sparse growth of mesquite,

several kinds of cacti, some unidentified shrubs, and a very little grass.

In places in the midst of the lava small depressions occur, forming tiny alkali flats with the soil heavily incrusted with salts. A fleshy-leafed shrub was common here, but was not identified. It is probable that this situation should be recognized as a distinct habitat similar to the grama grass-joint fir community found in the depressions in the White Sands, but it covers a relatively small area, and for the present is included as part of the Malpais lava. The mammals secured were taken mostly at the edges of the lava around these small alkaline flats.

On the lava were taken a characteristic black pocket-mouse and a black woodrat, as well as a few other forms characteristic of rocky places in the nearby mountains.

DESERT MOUNTAIN SLOPE COMMUNITIES

Sotol-ocotillo community:

1907. *Sotol-ocotillo association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.

Perognathus intermedius intermedius. Rock pocket-mouse, 6.
Peromyscus eremicus eremicus. Cactus mouse, 1.
Peromyscus truei truei. Pinyon mouse, 1.
Neotoma albigula albigula. White-throated woodrat, 3.
Sylvilagus audubonii minor. Desert cottontail, 1.

The lower slopes of the Sacramento Mountains are covered by a vegetation indicative of extremely hot and arid conditions. At an elevation of about 5800 feet on the southerly slope overlooking Dry Canyon, where most of our study of this habitat was made, one of the most common shrubs is the fragrant catclaw (*Mimosa fragrans*). The small-leaved sumac (*Schmaltzia microphylla*) is also common. Sotol (*Dasylirion*) and ocotillo (*Fouquieria splendens*) are conspicuous, but at this place could not be considered dominant. The creosote bush and crucifixion thorn are present. Cacti of several types are numerous (see Bailey, 1913, pp. 14, 15). The general height of the thin vegetation is from 2 to 4 feet. Rocks, some

of large size, are common on the slopes, and provide shelter for small mammals. Only a very small amount of trapping was done at this place and further study would undoubtedly have added much to the list of mammals. As this location is near the upper limit of typical sotol-ocotillo community it is possible that at lower elevations the fauna and flora may be somewhat different. The lower limit of the community is reached at about 4500 feet.

The extreme upper limit of the desert slope is reached at about 6500 feet. On a southerly rocky slope of about this elevation, overlooking Box Canyon near Highrolls, sotol and ocotillo were numerous. A few prickly pear and other cacti were present, also a little rabbit brush and creosote bush, and numerous *Cercocarpus*. A low grass was common in tiny clumps. In this situation there was taken one rock pocket-mouse, one white-throated woodrat, and one pinyon mouse. Just a short distance higher cedars of the pinyon-cedar community were common, and it seems probable that the pinyon mouse wandered in from this habitat. It was not secured at the 5800 foot station.

Rocky arroyo community:

Perognathus penicillatus eremicus. Desert pocket-mouse, 3.
Perognathus intermedius intermedius. Rock pocket-mouse, 5.
Dipodomys merriami merriami. Merriam kangaroo-rat, 2.
Onychomys torridus torridus. Coues grasshopper-mouse, 1.
Reithrodontomys megalotis megalotis. Desert harvest-mouse, 1.
Peromyscus eremicus eremicus. Cactus mouse, 9.
Peromyscus maniculatus blandus. Chihuahua deer-mouse, 1.
Neotoma albigula albigula. White-throated woodrat, 2.
Sylvilagus audubonii minor. Desert cottontail, 1.

Very few of the canyons in the lower parts of the Sacramento Mountains contain permanent streams. Instead most have in summer only dry channels, where sand, gravel, and water-worn boulders give abundant evidence of the occasional occurrence of mountain torrents. These rocky arroyos often continue out across the alluvial fans formed on the plain at the mouths of the canyons.

Several plants seem characteristic of the rocky arroyo habitat. Among them the most conspicuous is a green shrub, *Atriplex acanthocarpa,* growing about 6 feet tall. Around the clumps of this shrub were taken many of the mammals secured. A few mesquites and creosote bushes invade the arroyos from the edges.

The arroyo habitat is narrow and is easily invaded by the animals and plants of the bordering habitats. In the lower mountains its inhabitants are in part those of the sotol-ocotillo association of the desert mountain slopes. On the alluvial fans its inhabitants are in part received from the creosote bush habitat through which it here passes.

About 4 miles north of Alamogordo an arroyo with an average width of about 10 yards crosses the creosote bush covered alluvial fan extending out from Dry Canyon. The elevation here is about 4500 feet. Further up, at an elevation of about 5500 feet in the same canyon, the arroyo habitat is surrounded mostly by the Sotol-ocotillo community. The only species of mammal found in both places was *Peromyscus eremicus. Onychomys torridus* and *Perognathus intermedius* were taken only at the higher elevation. All the other species listed from this habitat were taken only at the lower situation. However, trapping in both places was too brief to secure a complete list of the mammalian fauna of either location.

PINYON-CEDAR WOODLAND

A very definite belt on the western slope of the Sacramento Mountains is dominated by the pinyon pine (*Pinus edulis*) and several species of cedars (*Juniperus pachyphloea* and *J. monosperma*). The altitudinal limits of this belt extend between about 6300 and 7200 feet on exposed slopes and between about 5800 and 6800 feet on sheltered slopes. Below this belt is the desert slope, while above is the montane forest.

Few mammal species seem to be characteristic of the pinyon-cedar woodland on these mountains, and no form seems to be restricted to this belt, though the following species seem to reach their greatest abundance here:

Citellus grammurus grammurus. Rock squirrel.
Peromyscus truei truei. Pinyon mouse.
Neotoma mexicana mexicana. Mexican woodrat.

Of these species the Mexican woodrat and pinyon mouse both occur also in the region of montane forest higher on the mountains, and the rock squirrel ranges from the desert to the summit of the mountains. The jack-rabbit and the cottontail of the desert range up into this belt. Several forms characteristic of the montane forest range down into the pinyon-cedar belt: the chipmunk and tawny deer-mouse. The large brown bat was taken only in this belt, but probably occurs also in the montane forest. The canyon bat was taken here and in the desert.

Pinyon-cedar community:

1907. *Pinyon-cedar association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499.
1920. *Pinus-Juniperus association* Clements, Carnegie Institute Washington, Publ. 290, p. 197.

Citellus grammurus grammurus. Rock squirrel, numerous.
Eutamias cinereicollis canipes. Gray-footed chipmunk, 3.
Perognathus intermedius intermedius. Rock pocket-mouse, 1.
Peromyscus maniculatus rufinus. Tawny deer-mouse, 1.
Peromyscus truei truei. Pinyon mouse, 33.
Neotoma mexicana mexicana. Mexican woodrat, 9.
Lepus californicus texianus. Texas jack-rabbit, 2.
Sylvilagus audubonii minor. Desert cottontail, 5.
Odocoileus couesi. Coues deer, 1.

The cedars and the pinyon grow in a park-like stand usually with open spaces between the trees. A few scrub oaks occur, also scattered rose bushes. A small leaved sumac is numerous. There is also a low prickly pear, a prickly poppy, and several mustards. The ground is usually rocky or gravelly.

The most abundant mammals of this habitat are the pinyon mouse, the rock squirrel, and the Mexican woodrat.

Oak-poplar community:

Citellus grammurus grammurus. Rock squirrel, numerous.
Eutamias cinereicollis canipes. Gray-footed chipmunk, 1.

Peromyscus truei truei. Pinyon mouse, 6.
Neotoma mexicana mexicana. Mexican woodrat, 1.

In the bottom of the canyon about one-half mile southwest of Highrolls there is a somewhat mesophytic forest containing, among other deciduous trees, oak, cottonwood, cherry, and ash (Spalding, 1907, p. 12). Vines of grape and clematis are numerous, and there are a few poison oak. A small leaved sumac is common. A few yellow pines occur and the pinyon and cedar of the adjacent slopes invade on the sides.

The community is very narrow in most places, and the mammals recorded are all found also in the pinyon-cedar community.

Aerial community (pinyon-cedar belt):

Pipistrellus hesperus hesperus. Canyon bat, 1.
Eptesicus fuscus fuscus. Large brown bat, 1.

In the canyon just northwest of Highrolls the canyon bat was numerous in flight in the July evenings. The large brown bat was less common.

MONTANE FOREST

Mammals characteristic of the montane forest region of the Sacramento Mountains include:

Sorex obscurus neomexicanus. Dusky shrew.
Eutamias cinereicollis canipes. Gray-footed chipmunk.
Sciurus fremonti lychnuchus. Spruce squirrel.
Thomomys fulvus fulvus. Fulvous pocket-gopher.
Peromyscus maniculatus rufinus. Tawny deer-mouse.
Microtus mordax mordax. Merriam vole.

The chipmunk and deer-mouse range down into the pinyon-cedar woodland. From the pinyon-cedar woodland the pinyon mouse, Mexican woodrat, and rock squirrel range up into this forest area.

Although the Sacramento Mountains (including the White Mountains) are separated geographically from other mountains to the north, their characteristic mammals are very sim-

ilar to those of Colorado. As has been previously suggested this probably indicates a closer ecological connection at some earlier period, likely at the time of the last glaciation, when the forest would presumably reach a lower altitude on the mountains and intervening areas.

At the present time there seems to be practically a continuous connection in pinyon-cedar woodland with the Sangre de Cristo range to the north, and a depression in the belt levels of 2000 feet or less would probably be sufficient to allow the characteristic Sacramento Mountain mammals and plants to find their way from Colorado south to where they now occur.

Oak chaparral community:

Peromyscus maniculatus rufinus. Tawny deer-mouse, 2.
Peromyscus truei truei. Pinyon mouse, 22.
Microtus mordax mordax. Merriam vole, 2.

Brush of a chaparral type covers very extensive areas on the exposed western slope of the Sacramento Mountains, extending from the upper edge of the pinyon-cedar belt up to almost the summit of the mountains. At many places in this brush may be found the charred logs and stumps of large conifers. Also some of the component species of the chaparral grow beneath the pine forest in the places where this remains. The evidence seems clear that originally yellow pine forest occupied most of the exposed upper slopes of these mountains, and that the brush has become dominant following the burning and clearing of the yellow pines.

Just below Cloudcroft at an elevation of about 8500 feet scrub oaks (*Quercus* sp.) are the dominant shrubs in the chaparral, which here reaches a height of ten to twenty feet, thickly covering the mountain side. A locust (*Robinia*) is common, as are also several other unidentified shrubs. The slope is very steep and besides the numerous logs and stumps there are many small rocks to afford shelter for small mammals.

A somewhat different type of chaparral was studied by Bradt at an elevation of about 7000 feet on a ridge just south

of Highrolls. At this place a rose (*Rosa* sp.) is the dominant plant, and *Tetradymia linearis* is common. In this rose chaparral 14 pinyon deer-mice were trapped in one night. All the other mammals listed above were taken in the oak chaparral near Cloudcroft. However, only a very small amount of trapping was done in the chaparral habitat, and the mammalian fauna is certainly much greater than here indicated.

Yellow pine community:

1907. *Pine-spruce association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499 (in part).

Citellus grammurus grammurus. Rock squirrel, 1.
Eutamias cinereicollis canipes. Gray-footed chipmunk, numerous.
Thomomys fulvus fulvus. Fulvous pocket-gopher, 2.
Peromyscus maniculatus rufinus. Tawny deer-mouse, 2.
Peromyscus truei truei. Pinyon mouse, 3.

Our observations indicate that yellow pine (*Pinus ponderosa scopulorum*) at one time covered most of the exposed upper slopes of the Sacramento Mountains; but at the present time only scattered trees and small groves remain to indicate its former abundance. Near the lowest limit of its altitudinal range, about 7000 feet on this mountain slope, the yellow pine community is found only on sheltered northern slopes, while the pinyon-cedar community occupies the exposed slopes. With rise in altitude, however, the yellow pine quickly spreads over the exposed slopes also. On the higher elevations of the mountains the yellow pine community is found only on the exposed slopes, the sheltered slopes being occupied by the Douglas fir and spruce-fir communities.

Near Cloudcroft some remnants of the yellow pine forest are still standing in apparently nearly typical condition. As elsewhere in the Rocky Mountains the yellow pine grows in a rather open stand. At this place the underbrush is largely of scrub oaks and of young yellow pines, and it is probable that under primitive conditions a chaparral-like growth dominated by oaks was the characteristic understory of the yellow pine forest. The meagre results of our trapping undoubtedly yield

only a small sample of the mammalian fauna of the virgin yellow pine.

Douglas fir community:

1907. *Pine-spruce association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499 (in part).

Eutamias cinereicollis canipes. Gray-footed chipmunk, 5.
Sciurus fremonti lychnuchus. Spruce squirrel, 2.
Peromyscus maniculatus rufinus. Tawny deer-mouse, 56.
Neotoma mexicana mexicana. Mexican woodrat, 2.
Microtus mordax mordax. Merriam vole, 23.

On the western side of the ridge of the Sacramento Mountains near Cloudcroft, the sheltered slopes of the upper canyons are occupied by a heavy moist forest dominated by Douglas fir (*Pseudotsuga taxifolia*). The white fir (*Abies concolor*) is common. A similar type of forest covers large areas on the eastern side of the mountains. This forest has not been burned as much as the yellow pines, but some extensive patches of aspens indicate former fires.

In this forest occur a few oaks and other deciduous trees, and the underbrush is often quite heavy. Small mammals are quite numerous.

Spruce-fir community:

1907. *Pine-spruce association* Ruthven, Bull. Amer. Mus. Nat. Hist. 23: 499 (in part).

Sorex obscurus neomexicanus. Dusky shrew, 1.
Eutamias cinereicollis canipes. Gray-footed chipmunk, 1.
Peromyscus maniculatus rufinus. Tawny deer-mouse, 10.
Microtus mordax mordax. Merriam vole, 7.

On the northern slopes of the moist canyons on the eastern side of the Sacramento Mountains occurs a forest dominated by Engelmann spruce (*Picea engelmanni*) and white fir (*Abies concolor*). A small stand of this type was studied at Silver Spring, about six miles northeast of Cloudcroft. The elevation was about 8000 feet. Here a single specimen of the New Mexico shrew was taken as well as some of the commoner small mammals of the more wide-spread Douglas fir community.

Annotated List of Mammals

This list does not purport to include all the mammals occurring in the vicinity of Alamogordo, but does include all observations made by our party. In addition, a few records are included on the basis of statements by residents and by previous authors. Additional collecting and observation would considerably increase the number of species and would greatly extend the habitat records for some of the species. The principal gaps in our list are in the carnivores and ungulates. Both of these groups have been much reduced in numbers by the encroachment of civilization.

Names for the badger, coyote, and Coues deer, specimens of which were not secured by us, have been taken from Bailey's (1913) Life Zones and Crop Zones of New Mexico. Major E. A. Goldman assisted in the identification of the kangaroo-rats. The United States Biological Survey, through Hartley H. T. Jackson, kindly loaned specimens of pocket-mice for comparison.

Sorex obscurus neomexicanus. Dusky shrew.—An adult female was trapped in spruce-fir forest six miles northeast of Cloudcroft.

Pipistrellus hesperus hesperus. Canyon bat.—On the evening of July 16 a large number were observed flying over the pond and marsh at Malpais Spring, 15 miles west of Three Rivers. Twelve were shot. On the evening of July 19 one was shot as it with others similar in size was flying near the bottom of the canyon one-half mile southwest of Highrolls.

Eptesicus fuscus fuscus. Large brown bat.—On the evening of July 22 one was shot as it was flying over the bottom of the canyon one-half mile southwest of Highrolls. Several other large bats, probably of this species, were observed at this place.

Antrozous pallidus pallidus. Pallid bat.—Several large bats were observed in flight on the evening of July 16, over the pool and marsh at Malpais Spring, but only the more abundant and smaller *Pipistrellus* was secured. A dried mummy

of *Antrozous* was, however, found on the ground near the spring.

Taxidea taxus berlandieri. Badger.—Old burrows were noted in the more compact areas of gypsum on the White Sands 12 miles west of Alamogordo.

Canis mearnsi. Mearns coyote.—No coyotes were seen by our party, but a few tracks were noted on the White Sands. Feces were found in creosote bush habitat four miles northeast of Alamogordo.

Lynx species. Wild cat.—Reported by residents to occur sparingly on the desert plains, a record being given for mesquite. A dried carcass was found at Malpais Spring, but this may have been carried there from some other locality.

Citellus grammurus grammurus. Rock squirrel.—Several were seen alongside the railroad in mesquite just south of Alamogordo. They are numerous around rocks and at the edge of gully banks in the pinyon-cedar and oak-poplar habitats near Highrolls. One was seen in a railroad cut, near yellow pines, at Cloudcroft. A more complete account of this species has already been given by Bradley (1929, pp. 168–169).

Citellus spilosoma arens. Sand squirrel.—Two records for mesquite community near Alamogordo. A juvenile was shot July 12 in atriplex community 10 miles west of Alamogordo.

Cynomys ludovicianus arizonensis. Arizona prairie-dog.—About one mile north of Alamogordo there is a small prairie-dog town in mesquite. The vicinity of the town is almost denuded of vegetation.

Eutamias cinereicollis canipes. Gray-footed chipmunk.—Numerous at Cloudcroft about the tourist camp (yellow pine community); 5 were taken in Douglas fir forest; and 1 in spruce-fir forest. At Highrolls 3 were taken in pinyon-cedar woodland, and 1 in oak-poplar forest.

Sciurus fremonti lychnuchus. Spruce squirrel.—Two were taken in Douglas fir forest at Cloudcroft. A female taken July 27 contained 5 embryos of an average length of 37 mm.

Thomomys fulvus fulvus. Fulvous pocket-gopher.—Two were taken in the tourist camp at Cloudcroft in an area domi-

nated by yellow pine. Mounds were numerous in some tracts of yellow pine forest.

Thomomys lachuguilla. Lechuguilla pocket-gopher.—One was trapped in the city park at Alamogordo and another was taken in mesquite community.

A few mounds of pocket-gophers were noted on the White Sands, but no specimens were secured. The form occurring there may or may not be this species.

Perognathus flavus flavus. Baird pocket-mouse.—An adult male was taken in mesquite near Alamogordo.

Perognathus gypsi. White Sands pocket-mouse.—This almost white pocket-mouse was first discovered by our expedition (Dice, 1929, p. 1), living on the shifting dunes of the White Sands. Its color harmonizes very well with that of the gypsum sand. Five individuals were secured.

Perognathus penicillatus eremicus. Desert pocket-mouse.—Near Alamogordo 26 were taken in mesquite and 3 in a rocky arroyo.

Perognathus intermedius intermedius. Rock pocket-mouse.—At Highrolls one was taken in pinyon-cedar woodland and one at an elevation of about 6500 feet on a hot sotol-ocotillo slope overlooking Box Canyon. Five were taken in a rocky arroyo in the bottom of Dry Canyon, at an elevation of about 5500 feet, and 5 more on the shrubby desert slope (sotol-ocotillo) several hundred feet higher.

Perognathus intermedius ater. Malpais pocket-mouse.—This nearly black pocket-mouse was discovered (Dice, 1929, p. 2) on the black lava beds at Malpais Spring. Four individuals were secured.

Dipodomys merriami merriami. Merriam kangaroo-rat.—Near Alamogordo 27 were taken in mesquite, 5 in atriplex, 9 in creosote bush, and 2 in a rocky arroyo. Three were secured on the White Sands.

Dipodomys ordii ordii. Ord kangaroo-rat.—On the desert plain near Alamogordo 11 were taken in mesquite, and 4 in atriplex. Four were taken on the White Sands.

The total of 67 kangaroo-rats of two species, here recorded, lacks 20 of being the total number secured in the region. A number of those taken were in too poor condition for preservation, and were not identified as to species. Those not recorded as to habitat were almost all taken in the mesquite, and therefore the numbers of kangaroo-rats reported for this community are probably too low for both species.

Both species of kangaroo-rats occur together in the mesquite, in the atriplex, and in the sumac-yucca habitat of the White Sands. None of the Ord kangaroo-rat were, however, taken in creosote bush nor rocky arroyo, where a few of the Merriam kangaroo-rat occurred.

Onychomys leucogaster ruidosae. Ruidosa grasshopper-mouse.—One was taken in mesquite near Alamogordo, and one on the White Sands.

Onychomys torridus torridus. Coues grasshopper-mouse.—Near Alamogordo, 6 were taken in mesquite, and 2 in creosote bush. One was trapped in a rocky arroyo in Dry Canyon at an elevation of about 5500 feet.

A female taken July 14 at Alamogordo contained 2 embryos of a length of 18 mm.

Reithrodontomys megalotis megalotis. Desert harvest-mouse.—Near Alamogordo 30 were trapped in mesquite, 1 in a rocky arroyo, and 4 in an alkali meadow in a large wash on the desert plain.

Peromyscus eremicus eremicus. Cactus mouse.—Near Alamogordo 6 were taken among the shrubs along a rocky arroyo. In Dry Canyon, elevation about 5500 feet, 3 were taken along the rocky arroyo in the bottom of the canyon, and 1 among the shrubs of the sotol-ocotillo community on the desert slope several hundred feet above. Two were taken on the lava at Malpais Spring, 15 miles west of Three Rivers. The species is reported by Osgood (1909, p. 242) from Tularosa and Malpais Spring.

A female taken July 13 at Alamogordo contained 2 embryos of a length of 10 mm. The same female had two large botfly

larvae on her rump. Another female taken July 21 in Dry Canyon contained 3 embryos too small to measure.

The common name cactus mouse is here conferred on this species, for throughout its range it seems to be usually closely associated with rocky desert conditions, where cacti are also abundant. The name is more distinctive than the name desert mouse used by Osgood, for there are many other desert mice.

Peromyscus maniculatus rufinus. Tawny deer-mouse.—Near Highrolls 1 was taken in pinyon-cedar woodland. At Cloudcroft 2 were taken in oak chaparral, 2 in yellow pine forest, 56 in Douglas fir forest, 10 in spruce-fir forest, and 6 in modified Douglas fir and yellow pine forest at the tourist camp. In the montane forest it is the most abundant species of mammal.

Peromyscus maniculatus blandus. Chihuahua deer-mouse.—Fairly numerous on the desert plain near Alamogordo, where 111 were taken in mesquite, 10 in creosote bush, 1 in a rocky arroyo, 1 in atriplex, and 2 in an alkali meadow in a large wash in the midst of the desert plain. On the White Sands 8 were taken. Reported by Osgood (1909, p. 86) from Tularosa.

At Alamogordo a female with 4 very small embryos was taken July 9; another with 5 embryos 5 mm. long on the same day; and a third with 3 embryos 25 mm. long on July 12.

Peromyscus leucopus tornillo. Tornillo white-footed mouse.—Osgood (1909, p. 126) reports this species from Tularosa, but we did not secure any in this region.

Peromyscus truei truei. Pinyon mouse.—Fairly numerous in the pinyon-cedar woodland near Highrolls, 33 being taken in this habitat. Six were taken in the oak-poplar community. On a ridge two miles south of Highrolls 14 were taken in one night's trapping in a chaparral thicket dominated by rose (*Rosa* sp.). One was taken on the arid desert slope just north of Box Canyon. At Cloudcroft 8 were taken in oak chaparral and 3 in yellow pine forest.

A female taken July 19 near Highrolls contained 3 embryos too small to measure. Another female taken August 2 at Cloudcroft contained 4 embryos of a length of 15 mm.

The common name, pinyon mouse, here used for this species recognizes one of the important trees of its habitat over at least a considerable portion of its range in western North America.

Sigmodon minimus minimus. Desert cotton-rat.—Near Alamogordo one was taken in mesquite community and another in an alkali meadow in the bottom of a large wash.

Neotoma micropus canescens. Hoary woodrat.—Five were taken in mesquite near Alamogordo. July 8 an adult male and an adult female were taken at the same house of sticks built around the base of a clump of mesquite. A very young female, about one-fifth grown, was taken July 13.

Neotoma albigula albigula. White-throated woodrat.—Near Alamogordo 2 were taken among the shrubs in a rocky arroyo. One was taken and another seen in sotol-ocotillo community on the slopes of Dry Canyon at an elevation of about 5800 feet. Another was trapped in a sotol-ocotillo community on the north side of Box Canyon near Highrolls, at an elevation of about 6500 feet.

Neotoma albigula melas. Malpais woodrat.—At Malpais Spring an immature individual of this very dark colored woodrat was discovered (Dice, 1929, p. 3) on the black lava, where droppings were very abundant.

Neotoma mexicana mexicana. Mexican woodrat.—Nine were taken in the pinyon-cedar woodland a short distance southwest of Highrolls, and one was trapped in the oak-poplar woods in the bottom of the canyon at the same place. Near Cloudcroft two were secured in Douglas fir forest.

Microtus mordax mordax. Merriam vole.—At Cloudcroft 23 were trapped in Douglas fir forest, 7 in spruce-fir forest, and 2 in oak chaparral. A female taken July 29 contained 6 embryos, 17 mm. long.

Lepus californicus texianus. Texas jack-rabbit.—Numerous near Alamogordo in mesquite; relatively common in an alkali meadow in a wash; few in creosote bush and in atriplex. The species was not recorded from the rocky arroyo nor sotol-ocotillo communities, but it undoubtedly occurs in both. A few were noted in the White Sands. Near Highrolls two were

seen in pinyon-cedar woodland at elevations of about 6600 and 6900 feet, respectively. This latter elevation is probably about the extreme upper limit of its range in the region.

A female taken July 3 at Alamogordo had milk in the mammae. The mammae were two pairs pectoral, and one pair abdominal. Another female taken July 6 had milk in the mammae, and in the uterus were 3 embryos of a length of 40 mm. A third female taken July 13 had milk in the mammae and also had 3 very small embryos.

Sylvilagus audubonii minor. Desert cottontail.—A few occur in mesquite and creosote bush near Alamogordo; one was seen in a rocky arroyo. A few pellets believed to indicate this species were found in an alkali meadow in a large wash, and in atriplex community. Several were seen on the lava rocks of the Malpais, 15 miles west of Three Rivers. One was seen on the sotol-ocotillo desert slopes of Dry Canyon. Near Highrolls 5 were taken in pinyon-cedar woodland, where the cottontail ranged up to an elevation of about 7000 feet.

A female taken July 4 at Alamogordo had milk in the mammae and also had in the uterus 3 embryos of a length of 7 mm. The same individual had many cystircerci in the abdominal mesentery. The mammae were 1 pair pectoral, 2 pairs abdominal, and 1 pair inguinal. Another female taken July 8 had milk in the mammae but contained no embryos.

Odocoileus couesi. Coues deer.—A few white-tailed deer are reported by residents to occur in the Sacramento Mountains. One was seen by Whitlock in pinyon-cedar woodland near Highrolls.

Antilocapra americana subsp. Pronghorned antelope.—Reported by residents to occur sparingly on the White Sands and in other remote parts of the desert plains. Nelson (1925, pp. 41, 43) reports bands from this region.

Special Features of Mammalian Distribution in the Alamogordo Region

As might be expected, the mammalian fauna of the Tularosa Desert is strikingly different from that of the forested sum-

mits of the Sacramento Mountains. In general, the desert mammals are of different genera from those of the high mountain forests. Only one species, the rock squirrel, was found to range without modification from the desert to the mountain top. This species reaches its greatest abundance in the pinyon-cedar belt of the middle mountain slopes, and is rare in higher and lower life belts.

The pinyon-cedar woodland occupies an intermediate faunal position between the desert and the montane forest, receiving a part of its mammals from the desert and a part from the higher parts of the mountains. Although no species is restricted in distribution to the pinyon-cedar belt, a few forms are most abundant there.

The desert species of mammals are not uniformly distributed over the whole of the desert area, but there are several conspicuous physiographic or edaphic subdivisions, each with its special group of ecologic communities.

On the desert lower slopes of the mountains the abundance of rocks apparently makes favorable conditions for certain species of mammals usually associated with rocky habitats. On the other hand the sandy soil of parts of the desert plain, notably that occupied by the mesquite community, constitutes an especially favorable condition for some of the burrowing rodents. Also the strongly alkaline condition of the soil and ground water of parts of the desert plain undoubtedly affects mammalian distribution, both directly, and also indirectly by controlling plant distribution. On both the desert slope and the desert plain the prevailing color of the mammals is pale buff or tawny, matching roughly the color of the soils.

The mammals of the White Sands are mostly those of the surrounding desert plain, but there occurs also the peculiar White Sands pocket-mouse, whose color shows a striking approach to the color of these gypsum sands. This species has not been taken elsewhere than on the White Sands, and it seems probable that it has originated on this area of predominantly white background. A lizard (*Holbrookia maculata flavilenta*) was found to be apparently restricted to the

White Sands by Ruthven (1907, p. 523), who states that it is remarkably light-colored, "like the other lizards taken on the White Sands." Two spiders found on the White Sands are whitish in color (Townsend, 1897, p. 58). Two peculiar species of bees were found at the same place, though it is not stated what the colors of these bees are. On the other hand, the kangaroo-rats, deer-mouse, and grasshopper-mouse are apparently exactly like those found on the rest of the desert.

The fauna of the black lava Malpais includes several species of mammals characteristic of the rocky slopes of the adjacent mountains. Two of these species, the white-throated woodrat and the rock pocket-mouse, have on the Malpais peculiar black races. Neither the black woodrat nor the black pocket-mouse have been taken elsewhere than on the black lava, and it seems almost certain that these forms have developed on this extensive area of predominantly black background. It is interesting to note that blackish woodrats of another species (*Neotoma desertorum*) have been taken on black lava beds in other southwestern deserts (Goldman, 1910, p. 77).

All the situations which we studied on the desert plain, including the White Sands and the southern end of the Malpais, lie at practically the same elevation and are but a few miles apart. The general climate must, therefore, be very similar at all these places, and the presence of peculiar species and subspecies cannot be correlated with climatic differences. It would seem certain that the development of these peculiarly colored forms is in some way correlated with the color of the soil and rocks where they live.

The life-zones of the Alamogordo region, according to Bailey (1913), pl. 1), are Lower Sonoran, corresponding in general to my division of desert plain; Upper Sonoran, corresponding to my divisions of desert slope and pinyon-cedar woodland; and Transition and Canadian, corresponding to my division of montane forest. So far as I can determine, the Transition life-zone in this region would be made up of my yellow-pine and oak chaparral communities, while the Canadian life-zone

would be made up of my Douglas fir and spruce-fir communities.

My records indicate important differences in the mammalian faunas of the desert lower mountain slopes and the pinyon-cedar woodland, which are combined in the Upper Sonoran life-zone. A recognition of these differences in fauna seems highly desirable.

It is impossible to separate satisfactorily into different life-zones the yellow pine (Transition) and Douglas fir (Canadian) communities. These two communities occur side by side over a wide belt in these mountains as well as in the whole Rocky Mountain area. At many places, the yellow pine is characteristic of the exposed slopes, the Douglas fir of the sheltered slopes. On intermediate slopes the two species often occur mixed together. The differences in the mammalian faunas of the two habitats seem best shown by considering them to be distinct but closely related ecologic communities, rather than to belong to different climatic life belts.

The spruce-fir community in the Sacramento Mountains covers a relatively small area and nothing would seem to be gained by placing it in a subalpine forest division (Hudsonian life-zone). If the mountains were higher such a subalpine forest would undoubtedly be developed, but in these mountains it seems preferable to recognize the spruce and fir forest as an important community in an area dominated by montane forest.

The classification of the ecological formations and associations of North America made by Weaver and Clements (1929, pp. 425–426) fits accurately the major mammalian communities of the Alamogordo region. The desert plains association of the prairie formation, includes all the desert communities described in this paper. The desert scrub formation of Weaver and Clements in the Alamogordo region is represented only by subclimax communities, grassland being the ultimate climax, although the grasses have now been almost completely destroyed by overgrazing. The woodland formation of Weaver and Clements is the same as my pinyon-cedar woodland; and my montane forest is included by them in the

petran montane forest association of the montane forest formation. My oak chaparral community represents the petran chaparral association, which in this region is subclimax.

The distribution of some of the species of *Peromyscus* shows striking limitations in the Alamogordo region. The cactus mouse (*Peromyscus eremicus*) seems to prefer the vicinity of rocks, being found in the Malpais lava, sotol-ocotillo, and rocky arroyo communities. It was not taken on the sandy desert plain.

The pale-colored Chihuahua deer-mouse (*Peromyscus maniculatus blandus*) is widely distributed on the desert plain, but was not taken on the mountain slopes. The high mountain forests are occupied by a dark-colored subspecies, the tawny deer-mouse (*Peromyscus m. rufinus*), which is there very common. A single individual of this subspecies was taken in the pinyon-cedar belt at Highrolls, where it is evidently very rare, for much trapping was carried on in this habitat without securing other individuals.

Throughout the whole width of the pinyon-cedar belt and the lower desert slopes of the mountains, a combined vertical distance of 2500 feet or more, deer-mice of the *Peromyscus maniculatus* group are rare. The characteristic *Peromyscus* of the pinyon-cedar belt is the pinyon mouse (*Peromyscus truei*), whose range thus separates the ranges of the two subspecies of *Peromyscus maniculatus* occurring in the Alamogordo region.

It is evident that on the western slope of the Sacramento Mountains near Alamogordo there can be little if any contact between the two subspecies of *Peromyscus maniculatus* living, respectively, on the desert plain and in the mountain-top forest. If any important intergradation occurs between these subspecies it must be in some other locality.

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PLATE I

FIGURE 1. Mesquite community on the desert plain 5 miles south of Alamogordo; elevation about 4200 feet; July 16, 1927. The soil is rather sandy. Sacramento Mountains in the distance.

FIGURE 2. Creosote bush community on an alluvial fan, 4 miles northeast of Alamogordo; elevation about 4400 feet; July 16, 1927. The soil is gravelly. In the distance are the very arid lower slopes of the Sacramento Mountains.

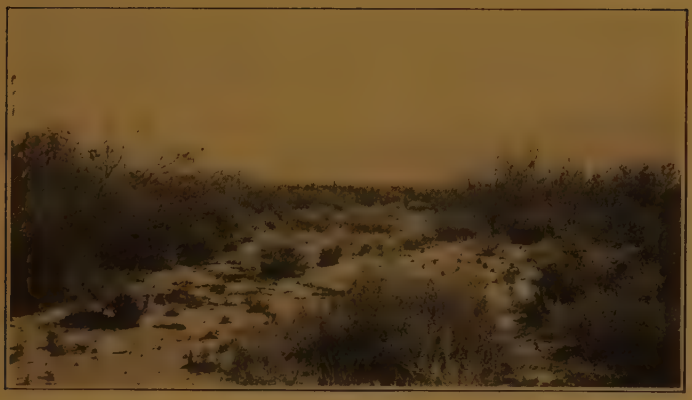

PLATE II

FIGURE 1. Sumac-yucca community on the White Sands, 12 miles west of Alamogordo; elevation about 4100 feet; July 10, 1927. The basin of a temporary alkaline pond lies in the middle distance. Near this place was taken the nearly white pocket-mouse, *Perognathus gypsi*. The kangaroo-rats, grasshopper-mouse, and deer-mouse taken here were not noticeably lighter in color than those from other parts of the desert.

FIGURE 2. Malpais lava community, near Malpais Spring, 15 miles west of Three Rivers; elevation about 4175 feet; July 17, 1927. The view is of the surface of the black lava bed. The pocket-mouse and woodrat found in this community are both nearly black in color, while the other mammals, so far as known, have the usual pale desert coloration.

PLATE III

FIGURE 1. Pinyon-cedar community near Highrolls; altitude about 6600 feet; July 24, 1927. This type of vegetation is characteristic of the middle life-belt on the slopes of the Sacramento Mountains.

FIGURE 2. Forested western slope of the Sacramento Mountains, near the summit at Cloudcroft; elevation about 8800 feet; August 1, 1927. In the foreground is the remnant of a yellow pine community, with scrub oaks forming a chaparral-like understory; on the slope in the distance is a Douglas fir community, somewhat modified by clearing and perhaps by fire.